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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/711,145

08/27/2004

Steven Shyng-Tsong T. Chen

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7590

09/15/2006

INTERNATIONAL BUSINESS MACHINES CORPORATION

DEPT. 18G

BLDG. 300-482

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EXAMINER

GREEN, PHILLIP

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 09/15/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 10/711,145	<b>Applicant(s)</b> CHEN ET AL.	
	<b>Examiner</b> Phillip S. Green	<b>Art Unit</b> 2823	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE \_\_\_\_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 12 June 2006.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-28 is/are pending in the application.
- 4a) Of the above claim(s) 6-8, 12 and 14-20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-5, 9-11, 13 and 21-28 is/are rejected.
- 7) ☒ Claim(s) 1 and 21 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |   |  |
|---|--|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                               | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                      | 5) <input type="checkbox"/> Notice of Informal Patent Application                      |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)<br>Paper No(s)/Mail Date ____ | 6) <input type="checkbox"/> Other: ____  |

## DETAILED ACTION

### *Claim Objections*

1. Claims 1 and 21 are objected to because of the following informalities: " a layer of oxide the silicon carbide material" is not fully understood; it appears that a preposition is missing. Appropriate correction is required.

### *Claim Rejections - 35 USC § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-5, 9-11, 13, 21-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hu et al. (US 6,660,627 B2) in view of Ference et al. (US 6,221,775 B1) in view of Morrow (US 6,872,666 B2).

Re claim 1, Hu discloses a method of forming an interconnect structure comprising the steps of:

depositing a dielectric layer **(38)**;

forming a hard mask over the dielectric material **(40)**;

etching trenches **(44)** in the dielectric material;

depositing a liner material **(46)** over the hard mask **(40)** and within the trenches **(50)**; and

overfilling the trenches **(44)** with a conductive material **(48)**;

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performing a first chemical mechanical polishing process to remove conductive material (48) which is atop the liner (46), thereby exposing the liner (46); (Note: Fig. 2D)

removing that portion of the liner (46) which is atop the hard mask (40); (Note: Fig. 2E)

removing a portion of the hard mask (42) using a wet etch process, thereby leaving in place the layer of silicon carbide (40); and (Note: Fig. 2F)

performing a second chemical mechanical polishing process to remove conductive material and liner material protruding from the trenches (Note: Col. 3, Line 41- Col. 4, Line 60).

However, Hu does not specifically disclose, wherein, the hard mask comprises: a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide.

Morrow discloses the method of making a damascene interconnect using a dual hard mask comprising a: a layer of silicon carbide material atop the dielectric layer (103), and a layer of oxide (108) atop the layer of silicon carbide (109) (Note: Col 3, Lines 1-26).

Both Hu and Morrow teachings are directed to fabricating a interconnect forming a dual mask. Therefore, the teachings of Hu and Morrow are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with a dual hard mask of a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide as taught by Morrow in order to form an

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interconnect because the dual hard mask enables different portions of dielectric layer (Note: Col 3, Lines 4-7).

Additionally, Hu and Morrow do not specifically disclose, removing a portion of the liner using a reactive ion etch (RIE) or a Gas Cluster Ion Beam (GCIB), leaving conductive material protruding.

Ference discloses a combined chemical mechanical polishing and reactive ion etching process, where CMP is performed with a process and slurry that is selective to the liner, such that the CMP process is stopped after removing all of the excess conductor but before removing all of the excess liner. RIE is applied to remove excess liner material and produce a protruding plug (Note: Col 5, Lines 57-67 and Fig. 6).

Both Hu and Ference teachings are directed to combined chemical mechanical polishing and reactive ion etching process. Therefore, the teachings of Hu and Ference are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with a conductive material protruding by using an reactive ion etch process as taught by Ference in order to form a convexly rounded, protruding plug to provide a surface which is easily coupled to a layer of Al formed by sputtering or other mechanisms during subsequent wafer processing steps (Note: Col 10, Lines 40-46).

Re claim 2, pertaining to claim 1 above, Hu discloses the dielectric layer comprising a low-k material (Note: Col 3, Lines 4-5).

Re claim 3, pertaining to claim 1 above, Hu discloses the dielectric layer comprising an ultra low-k material (Note: Col 3, Lines 4-5).

Re claim 5, pertaining to claim 1 above, Hu discloses the conductive material comprising copper (Note: Col 3, Lines 37-40).

Re claim 9, as applied to claim 1 in the paragraph above, Hu and Morrow discloses ensuring that the layer of oxide is thick enough such that the topographical variations after the first chemical mechanical polishing process and liner removal are entirely within the oxide portion of the hard mask (Note: Fig. 2).

Re claim 10, as applied to claim 1 in the paragraph above, Hu discloses an oxide with a thickness smaller than 1000 Angstrom.

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. In re Wertheim, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); In re Woodruff, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990) (The prior art taught carbon monoxide concentrations of "about 1-5%" while the claim was limited to "more than 5%." The court held that "about 1-5%" allowed for concentrations slightly above 5% thus the ranges overlapped.); In re Geisler, 116 F.3d 1465, 1469-71, 43 USPQ2d 1362, 1365-66 (Fed. Cir. 1997) (Claim reciting thickness of a protective layer as falling within a range of "50 to 100 Angstroms" considered prima facie obvious in view of prior art reference teaching that "for suitable protection, the thickness of the protective layer should be not less than about 10 nm [i.e., 100 Angstroms].") The court stated that "by stating that suitable protection' is provided if the protective layer is about' 100 Angstroms thick, [the prior art reference] directly teaches

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the use of a thickness within [applicant's] claimed range."). Similarly, a prima facie case of obviousness exists where the claimed ranges and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985) (Court held as proper a rejection of a claim directed to an alloy of "having 0.8% nickel, 0.3% molybdenum, up to 0.1% iron, balance titanium" as obvious over a reference disclosing alloys of 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium.).

"[ A ] prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a prima facie case of obviousness." In *re Peterson*, 315 F.3d 1325, 1330, 65 USPQ2d 1379, 1382-83 (Fed. Cir. 2003). However, if the reference's disclosed range is so broad as to encompass a very large number of possible distinct compositions, this might present a situation analogous to the obviousness of a species when the prior art broadly discloses a genus. *Id.* See also *In re Baird*, 16 F.3d 380, 29 USPQ2d 1550 (Fed. Cir. 1994); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); MPEP § 2144.08.

Re claim 11, pertaining to claim 1 above, Hu discloses the layer of silicon carbide material has a thickness smaller than 1000 Angstrom.

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990) (The prior art taught carbon monoxide concentrations of "about 1-5%" while



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the claim was limited to "more than 5%." The court held that "about 1-5%" allowed for concentrations slightly above 5% thus the ranges overlapped.); *In re Geisler*, 116 F.3d 1465, 1469-71, 43 USPQ2d 1362, 1365-66 (Fed. Cir. 1997) (Claim reciting thickness of a protective layer as falling within a range of "50 to 100 Angstroms" considered prima facie obvious in view of prior art reference teaching that "for suitable protection, the thickness of the protective layer should be not less than about 10 nm [i.e., 100 Angstroms].") The court stated that "by stating that suitable protection' is provided if the protective layer is about' 100 Angstroms thick, [the prior art reference] directly teaches the use of a thickness within [applicant's] claimed range."). Similarly, a prima facie case of obviousness exists where the claimed ranges and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985) (Court held as proper a rejection of a claim directed to an alloy of "having 0.8% nickel, 0.3% molybdenum, up to 0.1% iron, balance titanium" as obvious over a reference disclosing alloys of 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium.).

"[ A ] prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a prima facie case of obviousness." *In re Peterson*, 315 F.3d 1325, 1330, 65 USPQ2d 1379, 1382-83 (Fed. Cir. 2003).

However, if the reference's disclosed range is so broad as to encompass a very large number of possible distinct compositions, this might present a situation analogous to the obviousness of a species when the prior art broadly discloses a genus. *Id.* See also *In*



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re Baird, 16 F.3d 380, 29 USPQ2d 1550 (Fed. Cir. 1994); In re Jones, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); MPEP § 2144.08.

Re claim 13, pertaining to claim 1 above, Hu discloses a second chemical mechanical polishing process using an abrasive-free or low-abrasive polish to obtain a very high selectivity between the conductive material and the second portion of the hard mask (Note: Col 4, Lines 36-59).

Re claim 21, Hu discloses a method of forming an interconnect structure comprising the steps of:

depositing a dielectric layer **(38)**;

forming a hard mask over the dielectric material **(40)**;

etching trenches **(44)** in the dielectric material;

depositing a liner material **(46)** over the hard mask **(40)** and within the trenches **(50)**; and

overfilling the trenches **(44)** with a conductive material **(48)**;

performing a first chemical mechanical polishing process to remove conductive material **(48)** which is atop the liner **(46)**, thereby exposing the liner **(46)**; (Note: Fig. 2D)

removing that portion of the liner **(46)** which is atop the hard mask **(40)**; (Note: Fig. 2E)

removing a portion of the hard mask **(42)** using a wet etch process, thereby leaving in place the layer of silicon carbide **(40)**; and (Note: Fig. 2F)

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performing a second chemical mechanical polishing process to remove conductive material and liner material protruding from the trenches (Note: Col. 3, Line 41- Col. 4, Line 60).

However, Hu does not specifically disclose, wherein, the hard mask comprises: a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide.

Morrow discloses the method of making a damascene interconnect using a dual hard mask comprising a: a layer of silicon carbide material atop the dielectric layer (**103**), and a layer of oxide (**108**) atop the layer of silicon carbide (**109**) (Note: Col 3, Lines 1-26).

Both Hu and Morrow teachings are directed to fabricating a interconnect forming a dual mask. Therefore, the teachings of Hu and Morrow are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with a dual hard mask of a layer of silicon carbide material atop the dielectric layer, and a layer of oxide atop the layer of silicon carbide as taught by Morrow in order to form an interconnect because the dual hard mask enables different portions of dielectric layer (Note: Col 3, Lines 4-7).

Additionally, Hu and Morrow do not specifically disclose, removing a portion of the liner using a reactive ion etch (RIE) or a Gas Cluster Ion Beam (GCIB), leaving conductive material protruding.

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Ference discloses a combined chemical mechanical polishing and reactive ion etching process, where CMP is performed with a process and slurry that is selective to the liner, such that the CMP process is stopped after removing all of the excess conductor but before removing all of the excess liner. RIE is applied to remove excess liner material and produce a protruding plug (Note: Col 5, Lines 57-67 and Fig. 6).

Both Hu and Ference teachings are directed to combined chemical mechanical polishing and reactive ion etching process. Therefore, the teachings of Hu and Ference are analogous.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide the Hu reference with a conductive material protruding by using an reactive ion etch process as taught by Ference in order to form a convexly rounded, protruding plug to provide a surface which is easily coupled to a layer of Al formed by sputtering or other mechanisms during subsequent wafer processing steps (Note: Col 10, Lines 40-46).

Re claim 22 and 27, pertaining to claim 21 above, Hu discloses the layer of silicon carbide material with a thickness smaller than 1000 Angstrom.

In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. In re Wertheim, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); In re Woodruff, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990) (The prior art taught carbon monoxide concentrations of "about 1-5%" while the claim was limited to "more than 5%." The court held that "about 1-5%" allowed for concentrations slightly above 5% thus the ranges overlapped.); In re Geisler, 116 F.3d

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1465, 1469-71, 43 USPQ2d 1362, 1365-66 (Fed. Cir. 1997) (Claim reciting thickness of a protective layer as falling within a range of "50 to 100 Angstroms" considered prima facie obvious in view of prior art reference teaching that "for suitable protection, the thickness of the protective layer should be not less than about 10 nm [i.e., 100 Angstroms].") The court stated that "by stating that suitable protection' is provided if the protective layer is about' 100 Angstroms thick, [the prior art reference] directly teaches the use of a thickness within [applicant's] claimed range."). Similarly, a prima facie case of obviousness exists where the claimed ranges and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985) (Court held as proper a rejection of a claim directed to an alloy of "having 0.8% nickel, 0.3% molybdenum, up to 0.1% iron, balance titanium" as obvious over a reference disclosing alloys of 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium.).

"[ A ] prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a prima facie case of obviousness." In *re Peterson*, 315 F.3d 1325, 1330, 65 USPQ2d 1379, 1382-83 (Fed. Cir. 2003). However, if the reference's disclosed range is so broad as to encompass a very large number of possible distinct compositions, this might present a situation analogous to the obviousness of a species when the prior art broadly discloses a genus. *Id.* See also *In re Baird*, 16 F.3d 380, 29 USPQ2d 1550 (Fed. Cir. 1994); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); MPEP § 2144.08.

Re claim 23 and 26, as applied to claim 21 in the paragraph above, Hu discloses an oxide with a thickness smaller than 1000 Angstrom.

In the case where the claimed ranges “overlap or lie inside ranges disclosed by the prior art” a prima facie case of obviousness exists. In *re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); In *re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990) (The prior art taught carbon monoxide concentrations of “about 1-5%” while the claim was limited to “more than 5%.” The court held that “about 1-5%” allowed for concentrations slightly above 5% thus the ranges overlapped.); In *re Geisler*, 116 F.3d 1465, 1469-71, 43 USPQ2d 1362, 1365-66 (Fed. Cir. 1997) (Claim reciting thickness of a protective layer as falling within a range of “50 to 100 Angstroms” considered prima facie obvious in view of prior art reference teaching that “for suitable protection, the thickness of the protective layer should be not less than about 10 nm [i.e., 100 Angstroms].” The court stated that “by stating that suitable protection’ is provided if the protective layer is about’ 100 Angstroms thick, [the prior art reference] directly teaches the use of a thickness within [applicant’s] claimed range.”). Similarly, a prima facie case of obviousness exists where the claimed ranges and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985) (Court held as proper a rejection of a claim directed to an alloy of “having 0.8% nickel, 0.3% molybdenum, up to 0.1% iron, balance titanium” as obvious over a reference disclosing alloys of 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium.).

"[ A ] prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a prima facie case of obviousness." In re Peterson, 315 F.3d 1325, 1330, 65 USPQ2d 1379, 1382-83 (Fed. Cir. 2003). However, if the reference's disclosed range is so broad as to encompass a very large number of possible distinct compositions, this might present a situation analogous to the obviousness of a species when the prior art broadly discloses a genus. Id. See also In re Baird, 16 F.3d 380, 29 USPQ2d 1550 (Fed. Cir. 1994); In re Jones, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); MPEP § 2144.08.

Re claim 25, pertaining to claim 21 above, Hu and Morrow and Ference disclose further comprising the step of ensuring that the layer of oxide is thick enough such that the topographical variations after the first chemical mechanical polishing process and liner removal are entirely within the oxide portion of the hard mask (Note: Hu; Col 4, Lines 36-59).

Re claim 28, pertaining to claim 1 above, Hu discloses a second chemical mechanical polishing process using an abrasive-free or low-abrasive polish to obtain a very high selectivity between the conductive material and the second portion of the hard mask (Note: Col 4, Lines 36-59).

### ***Conclusion***

4. Claims 6-8, 12, 14-20 have been canceled.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP

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§ 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

### ***Correspondence***

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phillip S. Green whose telephone number is 571-272-7024. The examiner can normally be reached on Monday thru Thursday 8:30 am to 6:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on 571-272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.



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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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09/06/2006

  
BROOK KEBEDE  
PRIMARY EXAMINER